Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) Final image at infinity. ✔

Accept answers which describe how the telescope is set up with named lenses unless f_o and f_e are used e.g.

the focal plane/point of the eyepiece and objective lenses are co-incident.

OR

'distance between lenses is $f_o + f_e$'

Condone 'rays leaving eyepiece/entering eye are parallel'

If F_o and F_e are used they must be defined.

1

(b) 100 converging 5 converging ✔

1

(c) (Each step on magnitude scale is 2.51)

(Hence) $2.51^x = 40$

$x = \log_{2.51}(40) = 4(.01)$

OR

Adding 6 to their x ✔

(6 + 4 =)10 ✔

Condone trial and error (2.51^1, 2.51^2,...).

Award MAX 1 if no working shown for a bald correct answer.

2

(d) (Collecting power of telescope is)

$\left(\frac{60}{7}\right)^2$ = 73 or 74 (times greater than naked eye) ✔

MP1 can be given for 73 or 74 seen.

Accept $\left(\frac{7}{60}\right)^2$ = 0.014 for MP1

73 (or 74) is greater than 40 so the astronomer can see WASP-82. ✔

Allow an ecf in MP2 from '8.6 times greater'

($\frac{60}{7}$ = 8.6) , with idea that 8.6 is less than 40 and therefore astronomer cannot see Wasp-82.

Allow ecf in MP2 for an arithmetic error in MP1.

2

(e) Two clear reasons given ✔✔

Correct justification linked to one reason ✔

Reason	Justification
Better/greater quantum efficiency	A greater proportion of (incident) photons are detected
Can expose for long periods / many images can be combined	More light is collected / better image contrast
Can operate remotely	The telescope can be positioned where light pollution/atmospheric absorption is minimised
Idea that it can detect (more) wavelengths beyond the visible	More energy is collected from the star

MAX 3

*If no justification given then **MAX 2**.*

In the first row:

Do not allow 'efficiency' alone.

The reason and justification marks can both be awarded for an answer based on the definition of 'quantum efficiency' e.g.a greater proportion/ percentage of the incident photons are detected (by the CCD).

In the justification condone 'light' for 'photons' and condone 'number' for 'proportion'

Treat 'image processing' as neutral.

Ignore references to resolution.

3

[9]

Q2.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1- or 2-mark (L1), 3- or 4-mark (L2) and 5- or 6-mark (L3) answer. Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
6	All three areas (as outlined alongside) covered with at least two aspects covered in some detail. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
5	A fair attempt to analyse all three areas, with two areas discussed successfully and one area partially.
4	Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be gaps, there should

	only be an occasional error.
3	One area discussed successfully and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.
2	Only one area discussed successfully, or makes a partial attempt at two areas.
1	One of the three areas covered partially. There are likely to be many errors or omissions.
0	No relevant analysis.

Area 1: Stars compared for colour
M40 B will appear more red than M40 A as it is cooler.
M40 A is an F/G star; M40 B is a K class star Therefore M40 A is white/yellow-white and M40 B is orange
Ignore calculation of λ_{max} unless linked correctly to colour.
Classes are related to colour/temperature

Area 2: Stars compared for brightness

M40 A will appear (~1.5 times) brighter than M40 B, as the apparent magnitude is 0.4 less than that of M40 B.
Difference in magnitude = 0.4
Ratio in brightness = $2.51^{0.4} = 1.5$

Area 3: Distance discussed

Powers compared:
Using $P = \pi A T^4$ gives
For A: $P = 5.67 \times 10^{-8} \times 4\pi \times (6.3 \times 10^9)^2 \times 6000^4 = 3.66 \times 10^{28}$ W
For B: $P = 5.67 \times 10^{-8} \times 4\pi \times (1.1 \times 10^{10})^2 \times 4700^4 = 4.22 \times 10^{28}$ W

As power output of **A** is less than that of **B** but **A** appears brighter, **A** must be closer and therefore they are not a binary.

[6]

Q3.

(a) Line of best fit drawn through origin. ✔

Evidence of $\frac{\Delta v}{\Delta d}$ used. ✔

Age in range 4.1 to 5.1×10^{17} s ✔

Accept lines that intersect v / km s $^{-1}$= 12000 somewhere between d / Mpc = 160 and 200

Do not accept use of H = 65 km s^{-1} Mpc^{-1} unless obtained from gradient.

3

(b) expansion is accelerating

OR

rate of expansion is increasing ✔

(due to) dark energy ✔

Treat descriptions of how the rate is increasing as neutral

Do not allow 'dark matter'

2

[5]